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LIFE CYCLE ASSESSMENT METHODOLOGIES AND DATABASES

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Abstract:
A huge number of methodologies, databases and software tools are available This paper presents a synthetic view about one of the most important action in eco-design about selection of methodologies and tools. Currently a project is under way to set up an Internet site on life-cycle assessment tools and services and life cycle inventory data in support of European Integrated Product Policy.

1 IMPACT ASSESSMENT AND WEIGHTING METHODOLOGIES

The impact assessment method is widely used by life cycle assessment practitioners around the world. All Ecoindicator reports are freely available to download [12]. There are several more methodologies to assess the environmental impacts within an LCA, among them: CML 2001 [11], EDIP 2003 [10], EPS 2000 [4].

1.1 Eco-Points Method

The *Eco-points Method* is characterized by following aspects:

- The Eco-points Method was developed in Switzerland and is based on the use of national government policy objectives.
- Environmental impacts are evaluated directly and there is no classification step.
- The evaluation principle is *the distance to target principle*, or *the difference between the total impact in a specific area and the target value*. (The target values in the original *Ecopunkten Method* were derived from target values of the Swiss government. A Dutch variant has been developed on the basis of the Dutch policy objectives.)
- The use of policy objectives is controversial given that a policy does not express the true seriousness of a problem. Various political, economic, and social considerations also play a role when formulating these objectives.
- The Eco-Points methods have been accepted as a useful instrument, even though objections can be raised against using politically established target levels. The lack of a classification step is also regarded as a disadvantage - only a very limited number of impacts can be evaluated.
- Eco-points Method was/is widely used in Switzerland and Germany. It is also used in Norway, the United Kingdom and The Netherlands.
- The Eco-Points Method is not so much an environmental indicator as an indicator “in conformity with policy”.

1.2 The Environmental Priority System (EPS)

The *Environmental Priority System* (EPS) is characterized by following aspects:

- The EPS system was used first for Volvo in Sweden.
- It is not based on governmental policy, but on *estimated financial consequences of environmental problems*.
- It attempts to translate environmental impact into a sort of social expenditure.
  - The first step is to establish the damage caused to a number of "safeguard objects" - objects that a community considers valuable.
  - The next step is to identify how much the community is prepared to pay for these things, i.e., the social costs of the safeguard objects are established.
  - The resulting costs are added up to a single figure.
- The EPS system includes either classification or normalization.

1.3 The Eco-Indicator (95 and 99)

The *Eco-Indicators* (95 and 99) are characterized by following aspects:

- The Eco-Indicator 95 was developed in a joint project carried out by companies, research institutes and the Dutch government.
- The aim was *to develop an easy to use tool for product designers* and the main outcome was a list of 100 indicators for the most significant materials and processes. By using these indicators a designer can easily make combinations and carry out his/her own LCA. No outside expert or software are needed. Companies such as Philips have calculated several hundred additional scores for specific materials, such electronics and batteries. With these scores designers are able to analyze their design in just a few minutes.
- Indicators have been drawn up for all life-cycle phases
  - the production of materials such as steel, aluminum, thermo-plastics, paper, glass;
  - production processes, such as injection molding, rolling, turning, welding;
  - transport by road, rail, and sea;
  - energy generating processes;
  - waste processing processes, such as incineration, dumping, recycling.
- The most recent revised version is called Eco-Indicator 99.

Eco-Indicator 95

- The evaluation method for calculating the Eco-Indicator 95 strongly focuses on the effects of emissions on the ecosystem.
- For the valuation, the distance to target principle is used, but the targets are based on scientific data on environmental damage and not on policy statements.
- The targets values are related to three types of environmental damage:
  - deterioration of ecosystems (a target level has been chosen at which "only" 5% ecosystem degradation will still occur over several decades);
  - deterioration of human health (this refers in particular to winter and summer smog and the acceptable level set is that smog periods should hardly ever occur again); human deaths (the level chosen as acceptable is 1 fatality per million inhabitants per year).
  - damage to mineral and fossil resources.

Eco-Indicator 99

Standard Eco/indicator 99 values are available for:

- *Materials.* The indicators for production processes are based on 1 kilo material.

- *Production processes*. Treatment and processing of various materials. Expressed for each treatment in the unit appropriate to the particular process (square meters of rolled sheet or kilo of extruded plastic).
- *Transport processes.* These are mostly expressed in the unit tonne/kilometer.
- *Energy generation processes*. Units are given for electricity and heat.
- *Disposal scenarios.* These are per kilo of material, subdivided into types of material and waste processing methods.

The *Eco-Indicator 99* scores are based on an impact assessment methodology that transforms the data of the inventory table into damage scores which can be aggregated, depending on the needs and the choice of the user, to damage scores per each of three comprehensive damage categories, or even to one single score.

The use of Eco-indicators does not solve all problems of designers. Eco-indicator value can only be used in the creative and conceptual and design phases. In the problem analysis phase and design phase Life Cycle Analysis can be applied to obtain detailed insight.

The following steps must always be followed to ensure correct application of the Eco-indicator 99:

1. Establish the purpose of Eco-indicator calculation.
2. Define Life Cycle.
3. Quantify materials and processes.
4. Fill in form.
5. Interpret the results.

2 LCA DATABASES

ProBas

ProBas ("Prozessorientierte Basisdaten für Umweltmanagement-Instrumente") is a web based database on life cycle data for a broad variety of processes and materials.

EcoInvent

The ecoinvent database has been developed by the Swiss Centre for Life Cycle Inventories. The database accommodates more than 2,500 datasets for products, services and processes often used in LCA case studies. The database is available on a commercial basis.

APME/Boustead data

The Association of Plastics Manufacturer (APME) published on its webpage ecoprofiles of a number of relevant plastics and basic chemicals. These eco-profiles, comprising major Life Cycle Inventory data is very helpful as upstream data also for the electrical and electronics sector.

3. LIFE CYCLE ASSESSMENT TOOLS – SCREENING AND FULL-SCALE

EIME

EIME, Environmental Information and Management Explorer is a pragmatic, commercial tool to model products:

• Modules representative of materials, components and processes usually used in electric and electronic industry are at the user's disposal to model products.

• Once the architecture of the product is built, the software calculates the environmental contributions by impact and module.

The EIME Database contains generic environmental data on the most commonly used materials and electronic parts within industry processes and transportation modules.

The EIME modules include quantitative life cycle flows, toxicology and regulatory information, product descriptions and end of life aspects. The life cycle analysis is in compliance with ISO 14040 standard. EIME is offered by CODDE [5].

eVerdEE

eVerdEE is a web based screening Life Cycle Assessment tool for European Small and Medium Enterprises. Its main feature is the adaptation of ISO 14040 requirements to offer easy-to-handle functions with sound scientific bases. An introductory course, accessible via the eco-SMEs webpage provides a description of the tool and a step-by-step guide with examples and exercises [7].

This project also provides a LCA training course for SMEs. This course is recommended for product designers, purchasers and environmental strategists – who want to have an introduction to Life Cycle Assessment (LCA).

The course has been produced in the context of the EU-project CASCADE. The document "LCA course for users of LCA data and results" was developed for CASCADE at Industrial Environmental Informatics, Chalmers University of Technology. It has been used as the basis for the web course with simplifications, inclusions and adaptations made by FEBE EcoLogic to make the language and the content more suitable for newcomers, especially from SMEs.

EUP EcoReport

Within the "*Eco-design of EuP methodology*" project a tool has been developed to assess the life cycle of energy-using products. Although, the Excel based tool is intended for product group assessments within the EuP legislative process and not as a tool for companies from the electrical and electronics sector it gives certain guidance to identify major environmental aspects of a product. The Excel sheets are downloadable for free, including a methodology report [8].

GaBi

The commercial software system *GaBi* is a tool for build up life-cycle-balances. *GaBi* supports the user with handling with a large amount of data and within modeling of the product life cycle. *GaBi* calculates balances of different types and assists the user in aggregating the results.

GaBi software assists the user – besides Life Cycle Assessment - within:

- Greenhouse Gas Accounting
- Life Cycle Engineering
- Design for Environment
- Energy Efficiency Studies
- Substance Flow Analysis
- Company Ecobalances
- Environmental Reporting
- Sustainability Reporting
- Strategic Risk Management
- Total Cost Accounting

GaBi includes several databases [9].

SimaPro

SimaPro is a commercial LCA tool to collect, analyze and monitor the environmental performance of products and services. The user can model and analyze complex life cycles in

a systematic and transparent way, following the ISO 14040 series recommendations. To get started with your LCA projects, SimaPro comes inclusive of several inventory databases with thousands of processes, plus the most important impact assessment methods [13].

Umberto

Umberto is a commercial software tool to model, calculate and visualize material and energy flow systems. It is used to analyze the process systems, either in a plant or a company, or, along a product life cycle. Results can be assessed using economic and environmental performance indicators. Cost data for materials and processes can be entered to support managerial decision making [14].

IDEMAT

Idemat is a computer database for designers, developed by the section for Environmental Product Development of the faculty of Industrial Design Engineering at the Delft University of Technology. It provides technical information about materials and processes in words, numbers and graphics, and puts emphasis on environmental information. The program has been developed to be used by students of technically oriented academic disciplines like Industrial Design Engineering, Civil Engineering, Material Science and Aerospace Engineering [15].

LCA-E

LCA-E was created in cooperation between IVF and CPM, Chalmers. The tool allows users to do simplified life cycle assessments of electronic circuit boards. The tool can show how different component selection and different operating conditions can change the environmental impact. All the text in the tool is in Swedish. The inputs from the user are: amount of components (of 14 different types), how many cm of wiring, energy use in normal operation and in stand-by mode and the lifetime of the component. The output is a LCI data or a weighted environmental impact for the circuit board. The user can evaluate the environmental impact from manufacture or the environmental impact from use or the impact from both. The use of the tool is simple and no special training of a user is needed for the handling of the tool. Once the user has entered data on the circuit board, the user have to select what type of results he wants and click on calculate. The result is presented both in tabular and graphical form [2].

LCALight

LCALight was developed at ABB Corporate Research. *LCALight* is a web-based LCA (Life Cycle Assessment) tool for "quick and adequate" environmental impact calculations. *LCALight* was developed for the ABB intranet to be used by all ABB employees. Due to the simplicity of the tool, it is well suited for self-learning and to demonstrate the LCA methodology.

Once a user has learned the methodology and starts to have questions that are more difficult than the tool can answer the user is ready to use a more advanced LCA tool.

LCALight can calculate environmental impact from materials, energy and transports. The *LCALight* tool contains LCI data (with metadata) for 45 materials, 47 electricity mixes, 6 fossil fuels and 9 transports [6].

World Wide LCA Workshop

The World Wide LCA Workshop is a web based tool developed by Chalmers University to organize and manage LCA projects. The workshop allows to calculate impact assessment indices as well as full LCAs [3].

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